Design of PLC-SCADA Based Fuel Control System for Thermal Power Station

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***Abstract*- Over the years the demand for high quality, greater efficiency and automated machines has increased in this globalised world. This paper summarizes the various stages of operations involved in the conversion of a manually operated fuel system in boiler towards a fully automated. The automation is further enhanced by constant monitoring of fuel using SCADA screen which is connected to the PLC by means of communication cable. In order to automate a power plant and minimize human intervention, there is a need to develop a SCADA system that monitors the plant and helps reduce the errors caused by humans. In this project SCADA system is used in monitoring the boiler parameter likes temperature, pressure, flow, level. Sensors are used to monitor the parameter and the sensed signals are processed by PLC and monitor with SCADA the signals are compared with the reference parameter and the respective valves of the parameter are adjusted with the monitoring and logic control system.**

Keywords: Supervisory Control and Data Acquisition (SCADA), Programmable Logic Controller (PLC), Inputs/Outputs tags, Programming Interface, Alarms.

I. INTRODUCTION

A. programmable logic controller

A programmable logic controller (PLC) or programmable controller is an industrial computer that has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, machines, robotic devices, or any activity that requires high reliability, ease of programming, and process fault diagnosis. Dick Morley is considered as the father of PLC as he had invented the first PLC, the Modicon 084, for General Motors in 1968. PLCs can range from small modular devices with tens of inputs and outputs (I/O), in a housing integral with the processor, to large rack-mounted modular devices with thousands of I/O, and which are often networked to They can be designed for many arrangements of digital and analog I/O, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. PLC are broadly classified into two based on the power supply as AC and DC and based on outputs they are classified into relay type and transistor type respectively. PLCs use built-in ports, such as USB, Ethernet, RS-232, RS-485, or RS-422 to communicate with external devices (sensors, actuators) and systems (programming software, SCADA, HMI). Communication is carried over various industrial network protocols, like Modbus, or EtherNet/IP. Many of these protocols are vendor specific. Other PLC and SCADA systems.

B. SCADA

Supervisory control and data acquisition (SCADA) is a control system architecture comprising computers, networked data communications and graphical user interfaces for high-level supervision of machines and processes. It also covers sensors and other devices, such as programmable logic controllers, which interface with process plant or machinery.

The operator interfaces which enable monitoring and the issuing of process commands, like controller set point changes, are handled through the SCADA computer system. The subordinated operations, e.g. the real-time control logic or controller calculations, are performed by networked modules connected to the field sensors and actuators.

The SCADA concept was developed to be a universal means of remote-access to a variety of local control modules, which could be from different manufacturers and allowing access through standard automation protocols. In practice, large SCADA systems have grown to become very similar to distributed control systems in function, while using multiple means of interfacing with the plant. They can control large-scale processes that can include multiple sites, and work over large distances as well as small distance. It is one of the most commonly-used types of industrial control systems, in spite of concerns about SCADA systems being vulnerable to cyberwarfare/cyberterrorism attacks.

II. LITERATURE SURVEY

Kalappan, K. Balachander & Amudha, Alagarsamy. (2017).

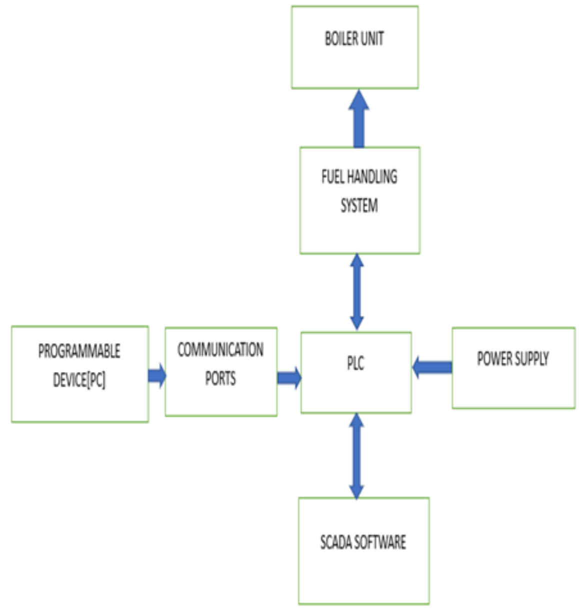
In this paper they have used Allen Bradley PLC for automation of Thermal power plant which uses light diesel oil as a fuel mechanism. In the existing system they just used PLC to automate the pumping process alone, not for the complete cycle of burning process, this is overcomed in the proposed model where PLC as a controlling devices for the Thermal power plant where it uses Lignite as a fuel for burning process and SCADA is used as a monitoring tool. SCADA provides a graphical representation of real time data which makes easier for the user to understand the entire operation and also provides various advantages such as saving of data logs, sharing across different file systems.

Rajesh Kumar, Roshan Kumar 2017).

In this paper the Fuel handling System (FHS) has discussed about different types of fuels that are generally used for initial startup of the boiler and it will be used until it reaches 30% of the load demand. From the paper we can see that the according to the load demand the percentage of the fuel used also varies say if there is a sudden load rise then fuel is turned on up to a certain period of time until the plant is capable of meeting up to the load demand. Moreover it gives a brief overview on how to handle fuel in Thermal power stations, these concepts are utilized in the project as well.

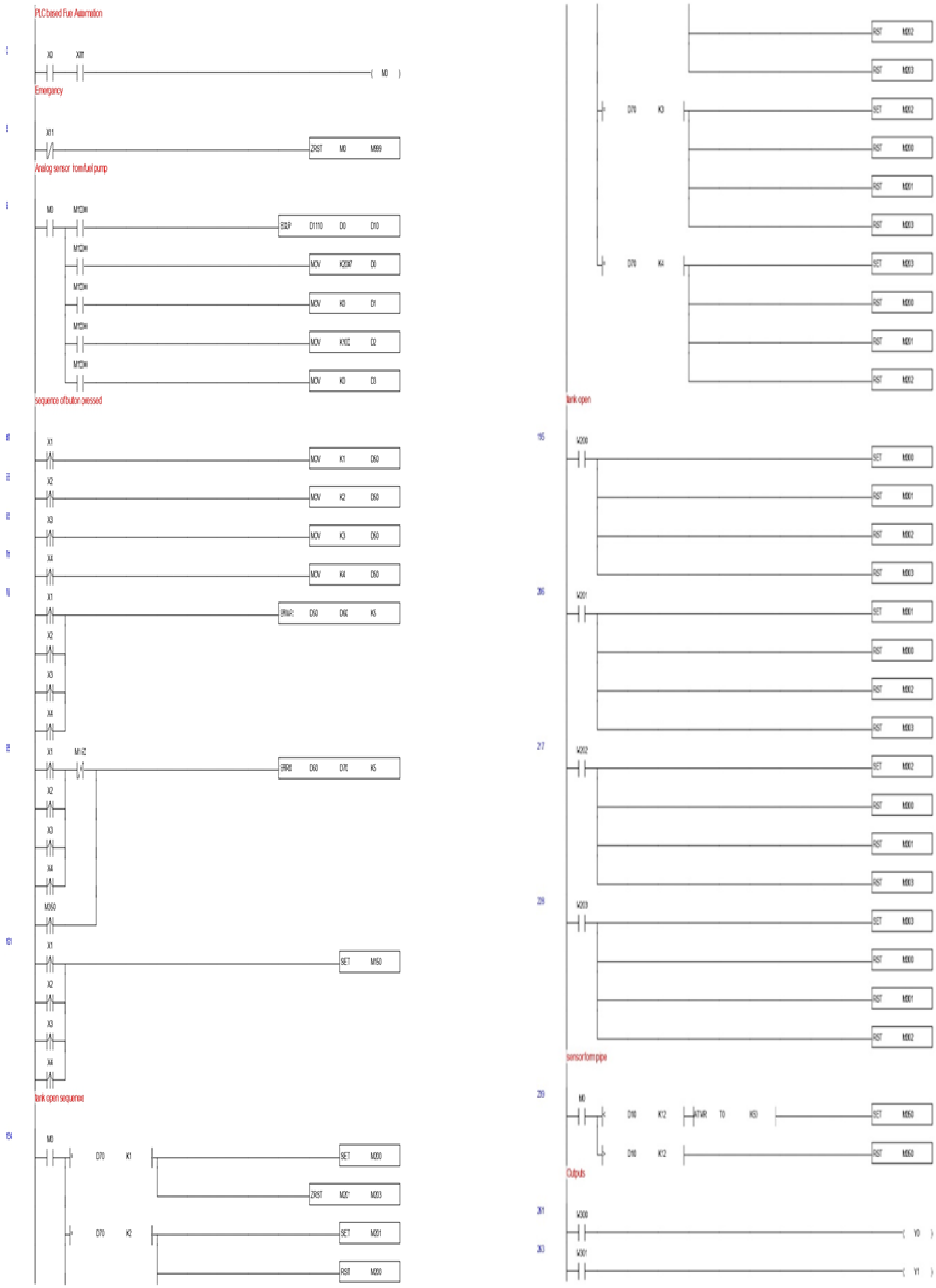
III. PROPOSED SYSTEM

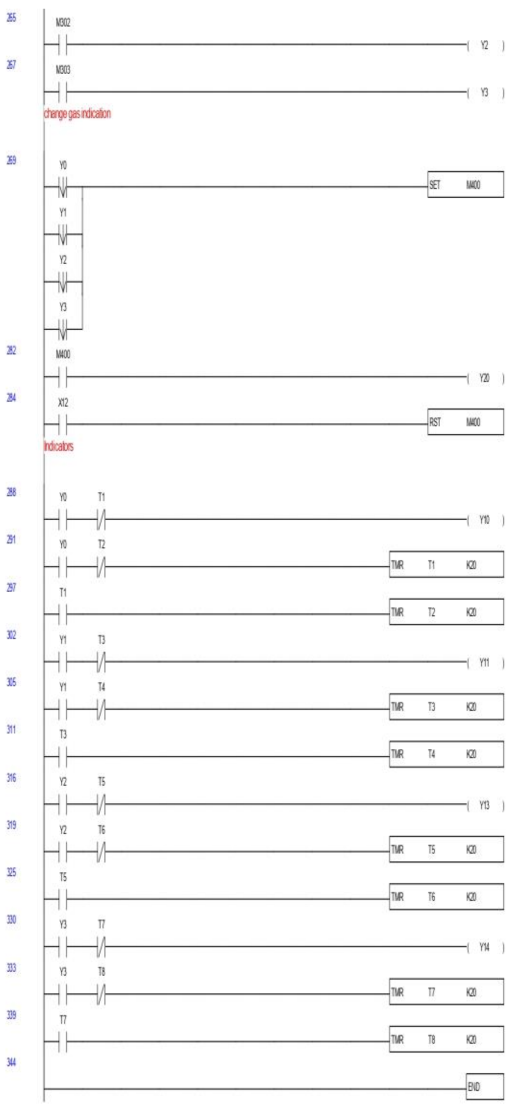
A. Block Diagram



The main aim of the project is to control the flow of the fuel fed into the furnace and it is controlled by opening and closing of the solenoid values at appropriate time by getting the signal from the delta plc. Here we have used Delta DVP20 EX2 model plc for the application and its more over a relay type plc which is most commonly used in industries. And the language used for the coding purpose is called as the ladder language and the software used is WPL soft V2.51 and the communication cable used for the interfacing of PC to PLC is RS232.And SCADA is used a monitoring tool for the entire developed model. The software used in SCADA is Intouch Wonderware 10.0.0.1 and the communication between the PLC and SCADA is through KEPSERVER software which acts as a link between the PLC and SCADA.

The program for the PLC is attached below:


PLC based Fuel Automation
Emergancy
Analog sensor from fuel pump
sequence of button pressed
tank open sequence
tank open
sensor from pipe
Outputs



List of switches used
X0 – start / stop switch
X11 – Emergency Switch
X1 – tank1 switch
X2 – tank2 switch
X3 – tank3 switch
X4 – tank4 switch
X12 – reset alarm
Y0 – tank1solenoid value
Y1 – tank2 solenoid value
Y2 – tank3 solenoid value
Y3 – tank4 solenoid value
Y10 – tank1 indicator
Y11 – tank2 indicator
Y13 – tank3 indicator
Y14- tank4 indicator
Y20 – tank change indicator

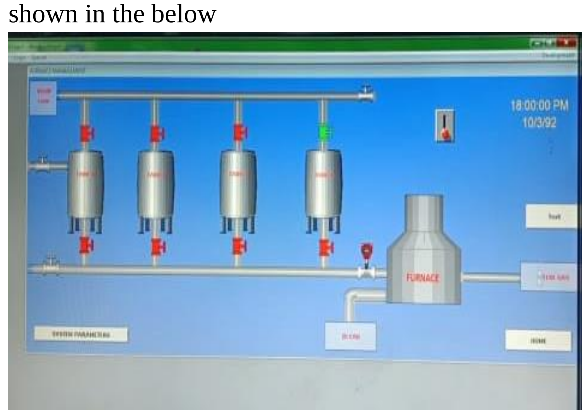
The simulation results of the WPL soft v2.51

Device Name	Comment	Status	T/C Set Value	Present Value (16 bi	Present Value (32 bi	Floating Point	Format	T/C Set Value Refer
M200		○						
M201		○						
M202		○						
M203		●						
M204		○						
Y0	TANK1 SOLENOID VALVE	○						
Y1	TANK2 SOLENOID VALVE	○						
Y2	TANK3 SOLENOID VALVE	○						
Y3	TANK4 SOLENOID VALUE	●						
D1110	Average of EX2 analog input channel 0 (A			K2000	K2000	F0.000	Signed Decimal	
D10				K97	K97	F0.000	Signed Decimal	
Y10	TANK1 INDICATOR	○						
Y11	TANK2 INDICATOR	○						
Y12		○						
Y13	TANK3 INDICATOR	○						
Y14	TANK4 INDICATOR	●						
Y20	GAS CHANGE INDICATOR	○						

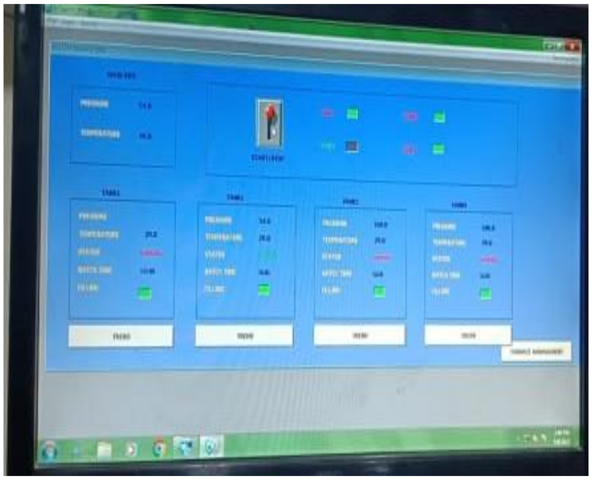
Tank switch process in simulation of WPL soft v2.51

Device Name	Comment	Status	T/C Set Value	Present Value (16 bi	Present Value (32 bi	Floating Point	Format	T/C Set Value Refer
M200		○						
M201		●						
M202		○						
M203		○						
M204		○						
Y0	TANK1 SOLENOID VALVE	○						
Y1	TANK2 SOLENOID VALVE	●						
Y2	TANK3 SOLENOID VALVE	○						
Y3	TANK4 SOLENOID VALUE	○						
D1110	Average of EX2 analog input channel 0 (A			K2000	K2000	F0.000	Signed Decimal	
D10				K97	K97	F0.000	Signed Decimal	
Y10	TANK1 INDICATOR	○						
Y11	TANK2 INDICATOR	○						
Y12		○						
Y13	TANK3 INDICATOR	○						
Y14	TANK4 INDICATOR	○						
Y20	GAS CHANGE INDICATOR	●						

SCADA is used as a monitoring tool for the entire operation developed by the PLC, here we used Intouch Wonderware 10.0.0.1 and the exact prototype of the existing industrial model is developed in the Scada software and the scripts are written to monitor all the parameters. The entire developed Scada model is shown in the below

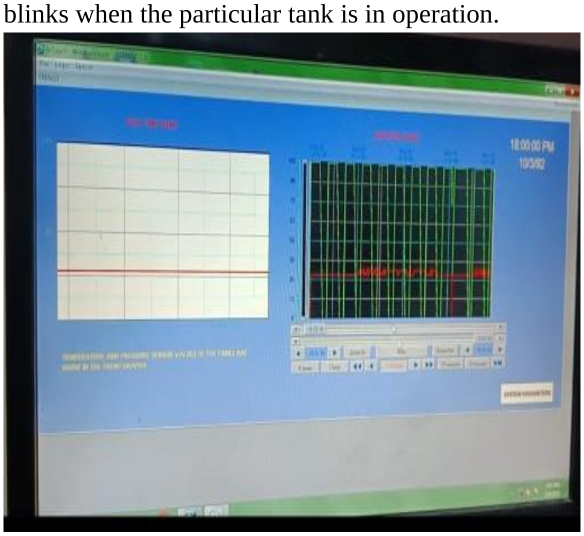


The above picture shows the schematic model developed in the scada software which simulates the real time environment, as seen there are four tanks and they are operated in a particular sequence and process of drain and filling is indicated by the green colour in the values and when the valves are closed they are indicated by the red in colour. There is a centralised operation switch where it can be on or off.



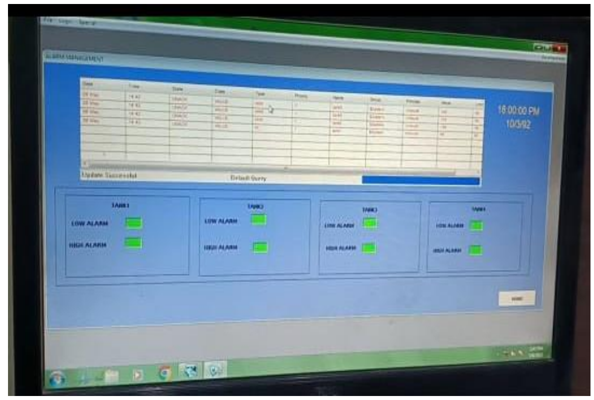
SYSTEM PARAMETER

In the system parameter window displays all operating tank parameters and it also displays the reading of pressure, temperature and operating time of each tank and also has a dedicated switch for turning on and off the system via scada there are also indicators which blinks when the particular tank is in operation.



TREND GRAPH

The above is the trend graph there are two trend graphs which displays both temperature and pressure of each tank, the graph on the left is called as the real time trend, as the name denotes this graph is a live graph and shows only live on field values and the graph on the right side is called as the historical trend and this graph has historical collection of temperature and pressure reading of past few days.



ALARM MANAGEMENT

The above is the Alarm management window there are two sensors places inside each tank one for the low-level sensor and high-level sensor and it will automatically indicate a warning in the Alarm management tool and also provides indications for each tank.

Scripts used in SCADA

application script

```
#declaring all the tanks are full in initial condition
tank1=100;
tank2=100;
tank3=100;
tank4=100;
t1 = 100;
t2= 100;
t3= 100;
t4= 100;
# tank operation sequence
IF switch==1 AND tank1>0
THEN
tank1=tank1 - 0.2;
ENDIF;
 IF switch==1 AND tank1<2 AND tank2>0
THEN
tank2=tank2 - 0.2;
ENDIF;
 IF switch==1 AND tank2<2 AND tank3 >0
THEN
tank3=tank3 - 0.2;
ENDIF;
IF switch==1 AND tank3<2 AND tank4>0
THEN
tank4=tank4 - 0.2;
ENDIF;
IF tank4<2
```

```
THEN
tank1=100;
tank2=100;
tank3=100;
tank4=100;
ENDIF;
IF switch==1
THEN
t1=t1 - 0.2;
ENDIF;
 IF switch==1 AND t1<2
THEN
t2=t2 - 0.2;
ENDIF;
 IF switch==1 AND t2<2
THEN
t3=t3 - 0.2;
ENDIF;
IF switch==1 AND t3<2
THEN
t4=t4 - 0.2;
ENDIF;
IF tank4<2
THEN
t1=100;
t2=100;
t3=100;
t4=100;
ENDIF;
FileWriteFields( "c:\\TANK11.csv",-1, "tank1" ,4 );
on show
temp=28;
while show  7 sec
IF switch==1 AND temp<32
THEN
temp= temp+1;
ELSE
temp=28;
ENDIF;
IF tank1>1 AND tank2==100
THEN
    sec=sec+1;
ENDIF;
IF tank2>1 AND tank3==100  AND tank1<=0
 THEN
    sec1=sec1+1;
ENDIF;
IF tank3>1 AND tank4==100 AND tank2<=0
 THEN
    sec2=sec2+1;
ENDIF;
IF tank4>1 AND tank3<=0
 THEN
    sec3=sec3+1;
ENDIF;
```

IV FUTURE SCOPE

Emergency diesel generator can be added to the existing model in order to prevent entire load shutdown during blackout conditions. Variable speed Drives can be added to the existing model to control the speed of the ID(induced Draft fan) and can be connected to the plc and communication can be established between the plc and the Drive so that according to the load the speed of the fan as well as the flow of the fuel can be controlled (turned on/off). For additional security purpose a security script can be added to the SCADA so that only authorised person can access the script or manage the changes in the files created and make changes. The traditional solenoid valves can be replaced with flow control valves so that the flow will be limited instead of entire cut off done in the solenoid valve case

V.CONCLUSION

In this project designed and implemented boiler automation using PLA and SCADA. Temperature and pressure are all measured using various sensors. PlC is used to control the operation, while SCADA is used to monitor the parameters. The entire setup will shutdown and automatic check values will open to release the steam and pressure if the temperature and pressure go above the predetermined value. To prevent catastrophic failure, an emergency alarm was activated, and automatic check values were opened.

REFERENCE

[1]C.G. Saracin, M. Saracin, M. Lupu, “Programmable logic controllers used in electric drives of an intelligent building,” 7th Int. Sym. on Advanced Topics in Electrical Engineering, pp. 1-6, 2011.

[2] K. Balachander, Dr. P. Vijayakumar, “Modeling, Simulation and Optimization of Hybrid Renewable Power System for Daily Load demand of Metropolitan

Cities in India", American Journal of Engineering Research.
[3] Vijay Kumar Khatri, Ahsan Javed Ghangro, Jetandar Kumar and Syed Jaad UI Haque., "Industrial Data Acquisition and Control System using two PLCs' Networked over MPI Network" (ISIEA2009)
[4] S.Kalaivani, M. Jagadeeswari, "PLC & SCADA based effective boiler automation system for thermal power plant, "International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 4 Issue 4, April 2015.
[5] Gary Dunning, Introduction to PLC, 2001.
[6] Liu Le, Wang Changsong, Wang Xingbing, "The research of the free mode communication between Delta PLC and PC," Mechanical Engineering & Automation,
[7] R. Keerthika, M. Jagadeeswari, "Coal conveyer belt fault detection and control in thermal power plant using PLC & SCADA. International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 4 Issue 4, April 2015.
[8] Dr. K. Balachander, Dr. A. Amudha, "PLC based control of fuel oil pump houses in thermal power station," Journal of Electronics Information Technology Science and Management, Volume 12, Issue 1,2022.